

**PHYTOTOXICOLOGY SURVEY REPORT:
FORD MOTOR COMPANY OF CANADA
ESSEX ALUMINUM PLANT - WINDSOR
1993**

JULY 1994

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 **Ontario**

**Ministry of
Environment
and Energy**

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ISBN 0-7778-2931-2

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Report No: SDB-043-3512-94

Abstract

Phytotoxicology Survey Report: Ford Motor Company of Canada Essex Aluminum Plant - Windsor (1993)

The second Phytotoxicology survey around the Ford Motor Company of Canada Essex Aluminum Plant was conducted in 1993. The 1992 survey had revealed elevated fluoride concentrations in grass and silver maple foliage attributable to HF emissions from the plant.

The survey consisted of sampling locations along the four cardinal compass bearings where grass tissue and, where possible, silver maple foliage samples were collected. Chemical analyses of the samples confirmed that the plant was the source of fluoride in the vegetation tissue and extended the area of influence of these emissions beyond what was suggested in the initial survey. However, the greatest impact was confined to the industrial land buffer around the plant. Injury to at least one sensitive plant species was identified within this area.

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1 Introduction

In 1992, the Phytotoxicology Section conducted the first vegetation survey around the Ford Essex Aluminum Plant (Ford-Essex) in Windsor. This survey was intended to assess emissions of hydrofluoric acid (HF) and hydrochloric acid (HCl) from the plant using the concentrations of fluoride and chlorine in the vegetation tissue as an indicator of the presence of these chemicals in the ambient air. A report on this 1992 survey was prepared and published under the title: *Phytotoxicology Survey Report: Ford Motor Company of Canada Essex Aluminum Plant - Windsor (1992), Report Number HCB-012-3512-93*.

That report reviewed the manufacturing processes that were responsible for the emissions, as well as the results of ambient air measurements of these chemicals by the Ministry of Environment and Energy mobile tandem mass spectrometer. Also discussed were the results of stack tests commissioned by the company, confirming that HF and HCl were emitted. This background information will not be repeated here and the reader is directed to the above named report.

2 1992 Survey in Brief

The 1992 survey established a network of 20 locations at which samples of unmowed grass were collected and analyzed for fluoride and chlorine. At four of these locations, silver maple foliage was also sampled. The chemical analyses revealed Ford-Essex as the source of fluoride in the vegetation. Chlorine concentrations were found to have a naturally high and variable background and the survey could not evaluate HCl emissions.

The report recommended repeating the survey in 1993 to verify the grass fluoride concentration patterns and expand the silver maple foliage network. A repeat of the chlorine analyses was not recommended. A survey to identify fluoride-induced injury to plants was suggested.

3 1993 Survey Design and Timing

On June 29, 1993, grass samples at the same 20 locations, along four transect lines, were collected. This date was chosen so that the collection preceded the annual Ford-Essex shutdown which occurs during the first two weeks of July. The timing of the 1992 grass sampling, which occurred about one month after the shutdown in 1992 may have contributed to some inconsistencies in the grass fluoride concentration patterns.

The silver maple collection occurred on September 29, 1993. This date was well past the early July shutdown period. It was also near the end of the growing season and therefore maximized the potential exposure period to HF. The collection occurred at nine locations; the four sampled in 1992 plus five new locations.

Figure 1 positions the grass and silver maple sampling locations in relation to the Ford-Essex plant.

During the September 29, 1993 sampling of tree foliage, other vegetation in the vicinity of the sampling location was examined for evidence of fluoride-induced injury.

FIGURE 1:

Grass and Silver Maple Sampling Locations - 1993



4 Sample Collection, Processing and Analysis

Grass sample collection involved locating suitable sample material, making a series of cuttings close to the ground, removing necrotic blades, flowering stems and foreign matter, and placing samples into labelled kraft paper bags. Duplicate samples were collected at each location.

Silver maple foliage samples were collected by cutting a branch from the side of the canopy facing Ford-Essex, removing the leaves and placing them into labelled kraft bags. Duplicate samples were collected.

All samples were delivered to the Phytotoxicology processing laboratory where they were manually screened to remove any remaining undesirable material, dried in a forced-draft oven, and ground in a stainless steel, rotating-blade (Wiley™) mill to pass through a one millimetre screen. Flint glass jars with polyethylene lids were used to contain the processed samples.

The samples were forwarded to the MOEE Laboratory Services Branch where the material was analyzed for fluoride. Briefly, the analysis involved extracting the sample in a weak acid solution and determining the fluoride ion concentration by specific ion electrode.

5 Survey Results

The results of the chemical analyses of the grass and silver maple samples, expressed as means of the duplicates, are given in Table 2. This table also contains Upper Limit of Normal (ULN) concentration guidelines for fluoride in grass and tree foliage. The ULN guidelines are explained in the appendix to this report.

The concentrations of fluoride in the grass and silver maple foliage samples are represented graphically in Figures 2 and 3. These figures also represent the 1992 data for comparison.

TABLE 2: Mean Fluoride Concentrations* in Grass Tissue and Silver Maple Foliage in the Vicinity of the Ford Essex Aluminum Plant, 1993		
Location	Grass (June 29)	Silver Maple (September 29)
N1	39	58 23 33
N2	19	
N3	4.5	
N4	2.7	
N5	3.6	
E1	183	54 45
E2	125	
E3	35	
E4	16	
E5	14	
S1	27	13
S2	23	
S3	3.0	
S4	3.2	
S5	2.7	
W1	106	188 45 20
W2	64	
W3	8.6	
W4	6.5	
W5	2.1	
ULN urban	not available	35
ULN rural	12	15
ULN = Upper Limit of Normal Guideline, see Appendix		
* micrograms per gram, mean of duplicate samples and analyses		

Figure 2:

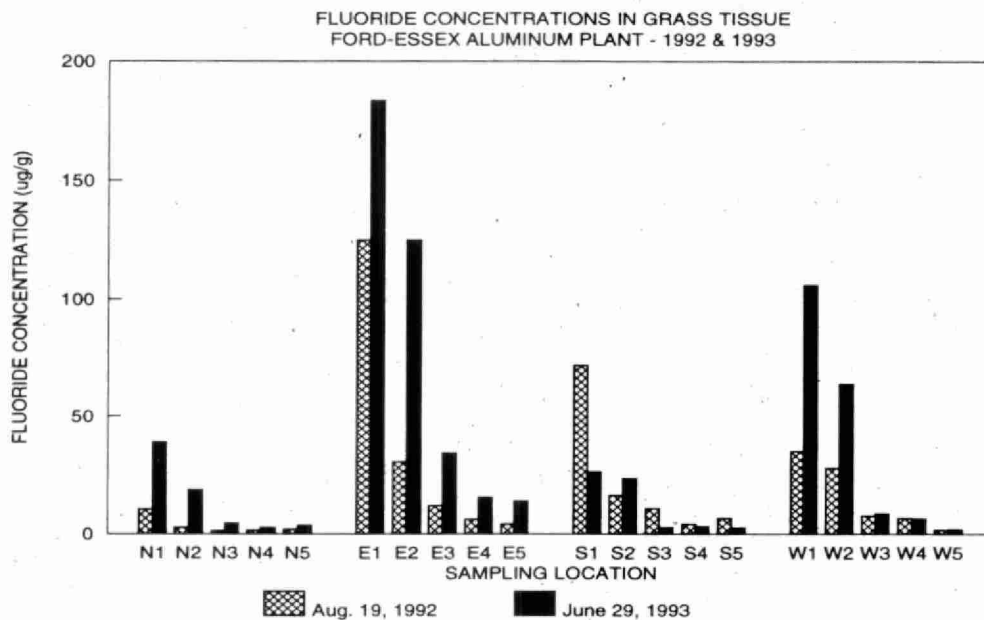
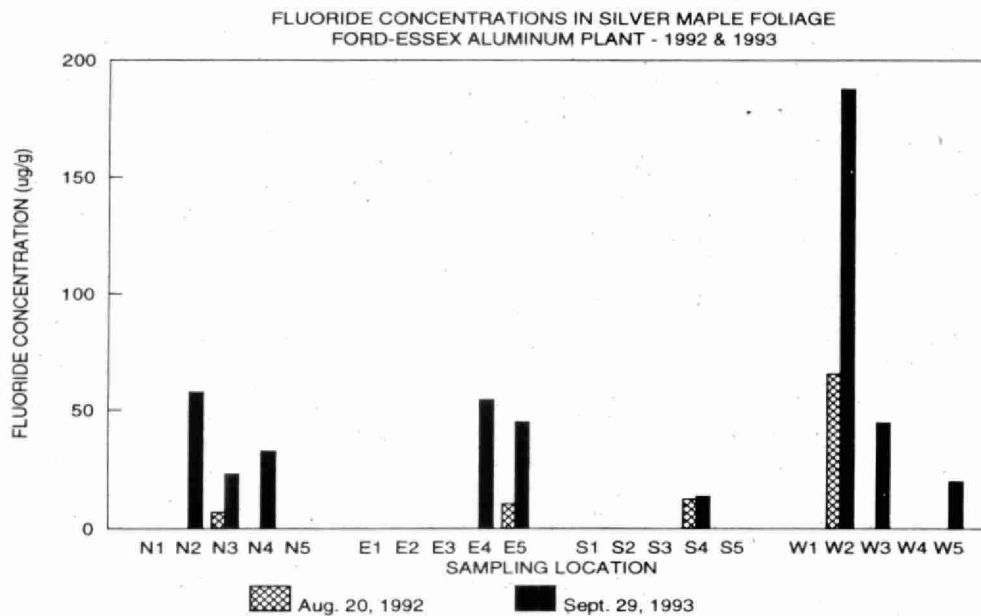


Figure 3:



6 Discussion

6.1 Fluoride in Grass Tissue

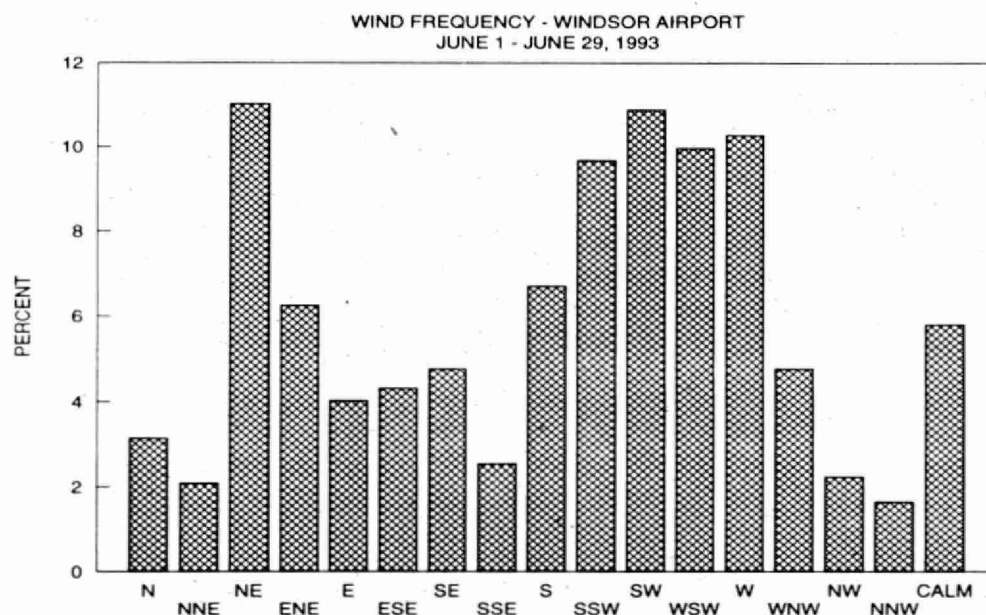
As was the case in the 1992 survey, the 1993 grass fluoride concentrations were elevated at sampling locations close to Ford-Essex. Figure 2 demonstrates that the highest concentration along each respective transect line occurred at the location closest to Ford-Essex. Overall, the 1993 concentrations were higher than in 1992, with the exception of those along the south transect.

There is no urban ULN guideline for fluoride in grass tissue. The rural guideline, 12 ug/g, was exceeded at 11 of the 20 sampling locations. It was substantially exceeded at the most proximal locations on the east and west transect lines, where the concentrations were 183 and 106 ug/g, respectively.

The 1993 grass fluoride concentrations along the north and south transects were noticeably lower than those along the east and west transects, at comparable distances from Ford-Essex. In 1992, this phenomenon was apparent along the north transect only and attempts to relate the concentration patterns to wind directions had limited success.

A wind direction review was performed again to explain the fluoride concentration patterns observed. Figure 4 represents the wind frequency at the Windsor airport during the 28 days preceding the June 29, 1993 grass sampling.

Figure 4:



The frequency of winds from the NNW, N and NNE directions was only 6.9%. This would explain the relatively low concentrations along the south transect. The frequency of winds from the SSW, S and SSE was considerably higher at 18.9%, yet the grass fluoride concentrations along the north transect were comparable to those along the south transect. Furthermore, the wind frequencies from the easterly and westerly direction series were 25.0% and 14.6%. These are similar to the frequency of southerly winds. However, grass fluoride concentrations along the east and west transects are much higher than along the north transect.

As was the case in 1992, an attempt to correlate prevailing winds and concentration patterns was only partially successful. Clearly there are factors affecting grass fluoride concentrations that have not been considered. Foremost among these would be the timing and intensity of HF emissions from Ford-Essex. Such an in-depth analysis was deemed unnecessary for this investigation, nor was it required to illustrate that Ford-Essex was the source of fluoride contamination.

Irrespective of the outcome of the prevailing wind-to-grass fluoride comparison, the consistency of the within-transect trends clearly demonstrate that Ford-Essex is the source of fluoride in the grass tissue. These fluoride emissions impact primarily on the industrial and commercial properties and agricultural lands in the immediate vicinity of Ford-Essex. However, these emissions do encroach onto nearby residential properties. The elevated grass fluoride concentration at Site E3, which is about 600 metres east of Ford-Essex demonstrates this fact.

6.2 Fluoride in Silver Maple Foliage

As previously mentioned, the silver maple foliage sampling was expanded to nine locations from four in 1992. Unlike the 1992 observations which demonstrated elevated foliar fluoride concentrations at only one of the four locations, in 1993, foliar fluoride concentrations exceeded the urban ULN guideline at five, and the rural ULN guideline at eight of the nine locations. The urban ULN guideline was exceeded at a distance of about one kilometre from the source. At this scale, residential neighbourhoods are undoubtedly within the sphere of influence of HF emissions from Ford-Essex.

The concentrations of fluoride in the foliar tissue were, in most cases, substantially higher in 1993 than at the same locations in 1992. This can be attributed in part to the timing of the collections. The 1993 collection, conducted in late September, was timed to maximize the potential degree of contamination. This does not mean that these are the maximum possible concentrations in the foliage. Silver maple produces new foliage throughout the growing season and fluoride concentrations will depend, in part, on the age profile of the leaves comprising the sample.

6.3 Injury Observations

The search for foliar injury caused by fluoride focussed on wild grape. This species is especially sensitive to fluoride and exhibits distinct injury symptoms. It is also widely distributed, growing on fences or in a prostrate form on the ground. Definitive fluoride injury was present on grape plants near Site E2. Probable fluoride injury was present on grape plants near Site N2. Both sites are about 400 metres from Ford-Essex.

7 Conclusions

The 1993 Phytotoxicology survey confirmed Ford-Essex as the source of fluoride in vegetation. The zone of influence as indicated by elevated concentrations extends at least one kilometre from the source. The ambient air concentrations near the source are of sufficient magnitude to induce injury to sensitive species of vegetation.

8 Future Investigations

Since the 1993 Phytotoxicology survey activities, Ford-Essex has installed dry lime injection systems to control HF and HCl emissions from the rotary furnaces. However, there have been no tests of the exhaust gas streams to evaluate the actual success of these controls (*Personal Communication with T. Sleder of Ford-Essex, April 6, 1994*). A subsequent Phytotoxicology survey conducted during the 1994 growing season would be useful in evaluating the success of the abatement action taken by Ford-Essex.

9 Appendix

Derivation and Significance of the MOEE Phytotoxicology "Upper Limits of Normal" Contaminant Guidelines.

The MOEE Upper Limits of Normal (ULN) contaminant guidelines represent the expected maximum concentration in surface soil, foliage (trees and shrubs), grass, moss bags, and snow from areas in Ontario not exposed to the influence of a pollution source. Urban ULN guidelines are based on samples collected from urban centres, whereas rural ULN guidelines were developed from non-urbanized areas. Samples were collected by Phytotoxicology staff using standard sampling procedures (reference: Ontario Ministry of the Environment, 1989, *Ontario Ministry of the Environment "Upper Limit of Normal" Contaminant Guidelines for Phytotoxicology Samples*, Phytotoxicology Section, Air Resources Branch; Technical Support Sections NE and NW Regions, Report No. ARB-138-88-Phyto, ISBN 0-7729-5143-8). Chemical analyses were conducted by the MOEE Laboratory Services Branch.

The ULN is the arithmetic mean plus three standard deviations of the suitable background data for each chemical element and parameter. This represents 99% of the sample population. This means that for every 100 samples that have not been exposed to a pollution source, 99 will fall within the ULN.

The ULNs do not represent maximum desirable or allowable limits. Rather, they are an indication that concentrations that exceed the ULN may be the result of contamination from a pollution source. Concentrations that exceed the ULNs are not necessarily toxic to plants, animals, or people. Concentrations that are below the ULNs are not known to be toxic.

ULNs are not available for all elements. This is because some elements have a very large range in the natural environment and the ULN, calculated as the mean plus three standard deviations, would be unrealistically high. Also, for some elements, insufficient background data is available to confidently calculate ULNs. The MOEE Phytotoxicology ULNs are constantly being reviewed as the background environmental data base is expanded. This will result in more ULNs being established and may amend existing ULNs.

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